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United States Department of Agriculture,
DIVISION OF ENTOMOLOGY.

THE HESSIAN FLY.

(*Cecidomyia destructor* Say.)

ECONOMIC IMPORTANCE AND GENERAL CHARACTERISTICS.

The Hessian fly is one of the principal enemies of the wheat crop, the minimum annual damage due to it being estimated at about 10 per cent of the product in the chief wheat-growing sections of this country, which indicates an annual loss of 40,000,000 bushels and over. An injury of from 50 per cent to a total failure of the crop is not infrequent in certain localities, and the resulting loss is proportionately greater.

The parent insect is a very fragile, dark-colored gnat or midge, about $\frac{1}{8}$ inch long and resembling somewhat closely a small mosquito. As commonly observed, however, more or less hidden in the base of young wheat plants or other small grains, the insect appears either in the form of a footless maggot, or larva, or in what is known as the flaxseed state, which corresponds to the chrysalis of other insects. The injury to the plant is done altogether by the larva, which feeds on the tissues and juices, and weakens and eventually destroys the plant.

DISTRIBUTION.

In common with many other of our more injurious farm pests, the Hessian fly is an importation from Europe; and the evidence points very strongly to the fact of its introduction in straw brought over with the Hessian troops during the war of the Revolution. It first appeared in injurious numbers in 1779 in the vicinity of the landing place of these troops three years before on Long Island, and has gradually spread westward, following the movement of settlement and wheat culture, reaching the Pacific Slope about 1884, and now practically extends throughout the wheat belt of the United States and Canada. It has long been known on the continent of Europe, covering the wheat belt from Russia eastward. It appeared in England in injurious numbers in 1886, and was first thought to have been recently introduced, but has since been proved to have been present long before in barley fields. In 1888 it was reported from New Zealand, and has since become an important grain pest there, thus nearly completing the circuit of the globe.

NATURAL HISTORY AND HABITS.

The Hessian fly is distinctively a wheat insect, but will breed also in barley and rye. What has been taken for this insect has, in recent years, been found occasionally in timothy and several wild grasses, but the insects in these cases are now known to be distinct from the Hessian fly, and the occurrence of the latter in plants other than those first named is extremely doubtful.

Over the bulk of the wheat area of the United States there are two principal broods of the Hessian fly annually, viz, a spring and a fall brood. There are, however, supplemental broods, both in spring and in fall, particularly in the southern wheat areas, but in the extreme northern area of the spring wheat belt there may be only a single annual brood—the progeny of the spring brood passing the late summer and the winter in the flaxseed state instead of developing a brood in autumn. It is possible, however, that in this region an autumn brood may develop in volunteer spring wheat.

Each generation is represented by four distinct states; viz, (1) egg, (2) maggot, or larva, (3) pupa, or flaxseed, and (4) mature winged insect.

The eggs are very minute and slender, pale red in color, and are usually deposited in regular rows of 3 to 5 or more on the upper surface of the leaf. In the case of the spring brood they are sometimes thrust beneath the sheath of the leaf on the lower joints. The number of eggs produced by a single female varies from 100 to 150.

The whitish maggots hatch in from three to five days and crawl down the leaf to the base of the sheath, embedding themselves between the sheath and stem, and develop on the substance of the wheat, causing more or less distortion and bulbous enlargement at the point of attack.

In a few weeks the larva contracts into a flaxseed-like object which is the puparium. In the case of the spring brood the insect remains in the flaxseed state during midsummer yielding the perfect insect for the most part in September; in the case of the fall brood the winter is passed in the base of the wheat in the flaxseed condition.

The fall brood works in the young wheat very near or at the surface of the ground. The spring brood usually develops in the lower joints of the wheat, commonly so near the ground as to be left in the stubble on harvesting. With spring wheat the attack is sometimes just at the surface of the ground, as in the case of the fall brood. The adults from the wintered-over flaxseed puparia emerge during April and May, most numerously before the middle of the latter month. The adults of the important fall brood emerge chiefly during September.

There is a supplemental spring brood following the main one and a supplemental fall brood preceding the main one. These supplemental broods, however, are comparatively unimportant, most of the individuals of the spring and fall broods going through the course of development first indicated. Under exceptional conditions the insect may remain dormant in the flaxseed state for a year or more and still bring forth the adult, a provision of nature which is doubtless intended to prevent the accidental extermination of the species. The migrating and scattering brood of adults is the one developed in the fall; the spring brood does not wander much from the field in which it is developed.

EFFECT ON WHEAT.

The first indication in the fall of the presence of the fly in wheat is the much darker color of the leaves and the tendency to stool out rather freely. This is very noticeable and gives the wheat for the time being a very healthy appearance. The leaves are also broader, but the upright central stems are wanting, having been killed by the fly. Later, the infested plants turn yellow or brown and die in part or altogether.

The spring brood of larvæ attacks tillers or laterals that have escaped the fall broods, dwarfing the stems and weakening them so that they usually fall before ripening and can not be successfully harvested.

The excessive stooling, or tillering, of wheat attacked by the fly is doubtless due to the natural tendency on the part of the plant to offset the injury by forming new lateral stems, and therefore a wheat that has a natural tendency in this direction is less apt to be seriously damaged by the fly. Other things being equal, also, wheat with stiff, flinty stems is less damaged by fly attack, chiefly because the straw does not bend or break so readily at the point weakened by the spring brood of larvae.

NATURAL ENEMIES.

The Hessian fly in the larval and pupal periods is subject to the attacks of important natural parasites—small four-winged flies which develop within the bodies of their hosts. There are several native parasites, and in Europe there are many others, one of which is remarkably prolific, and the Department has attempted its artificial introduction into this country. This species, *Entedon epigonus*, has been liberated in several States, and seems to have obtained a foothold, and considerable good may be expected from it.

In general, the parasites are effective only in limiting damage and are useful where other preventives are neglected, but can never take the place of active measures where perfect immunity is desired.

PREVENTIVE AND REMEDIAL MEASURES.

It is practically impossible to save a field once severely attacked by this fly, and under such circumstances it is better to plow the wheat under deeply and plant to corn or other spring crop. In case of mild infestation, the best procedure is the prompt use of fertilizers, which may enable the wheat to tiller sufficiently to yield a partial crop. Pasturing in fall of early-sown fields is also recommended, and may do some good by reducing the numbers of the pests. The measures against this insect are, however, of necessity, chiefly in the direction of preventing future injury. These are all in the line of farm methods of control and are arranged in the order of importance, as follows:

Late planting of winter wheat.—Abundant experience has indicated that in northern districts wheat sown late in September, say after the 15th or 20th, or in southern districts as late as October 1st, is comparatively uninjured by the fall brood, most of the flies having appeared and deposited their eggs or perished before wheat sown at this time will have sprouted. The actual date for safe planting will vary with the season and with the latitude; but if the right time be selected, neither early enough to be attacked by the fly nor yet so late as to cause danger of winter-killing, probably four-fifths of the injury to winter wheat may be avoided.

Burning stubble.—The fact has been noted in the life history that the second brood develops in the lower joints of the wheat and is left, for the most part, in the field in the flaxseed state at harvesting. All these individuals may be destroyed by promptly burning the stubble. Burning may be more easily effected if a rather long stubble be left, and especially if it be broken down by rolling. This step will very largely prevent an abundant fall brood of flies, and may be supple-

mented by burning all screenings of the wheat if thrashing precedes the fall appearance of the fly.

Plowing under stubble.—In line with burning, and of nearly equal importance, is turning the stubble under by deep plowing, and afterwards rolling the field to compact the earth and prevent any flies which may mature from issuing.

Rotation of crops.—The regular practice of a system of rotation in the growth of crops is of the utmost importance in avoiding fly damage. Its value may be offset at times by invasion from neighboring fields of wheat on other farms, but usually comparative freedom from attack will result and the benefit will extend to the other crops coming in the system adopted in checking the insect enemies of these at the same time.

Trap or decoy plantings.—One of the earliest preventives recommended and one of considerable value is the early planting of narrow strips of wheat to act as decoys to attract the flies with the object of turning the infested wheat deeply under with the plow in late fall. This procedure will greatly reduce the numbers of the pest and should give nearly complete immunity to late-planted wheat.

Destruction of volunteer wheat.—The supplemental fall brood antedating the principal brood may be prevented if all volunteer wheat be plowed under or destroyed within a few weeks after its appearance. This is of especial value in the North, where spring wheat is grown, and where the brood developed on the volunteer wheat may be the principal means of carrying the insect through the winter.

Growth of resistant wheats.—As indicated in the paragraph, "Effect on Wheat," the importance of selecting varieties which are less injured by the attacks of the fly, will be at once apparent. Such wheats are those having coarse, strong stems, and varieties which "tiller" freely or develop numerous secondary shoots. Among such wheats are the Underhill, Mediterranean, Red Cap, Red May, Clawson, etc.

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Approved:

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